

## PATENT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

United States Patent and Trademark  
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Crystal Plaza 2  
Washington, DC 20231  
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

<b>Date of mailing</b> (day/month/year) 11 February 1998 (11.02.98)	
<b>International application No.</b> PCT/US97/11521	<b>Applicant's or agent's file reference</b> CR9939
<b>International filing date</b> (day/month/year) 30 June 1997 (30.06.97)	<b>Priority date</b> (day/month/year) 01 July 1996 (01.07.96)
<b>Applicant</b> BAKER, Ralph, Thomas et al	

1. The designated Office is hereby notified of its election made:



in the demand filed with the International Preliminary Examining Authority on:

26 January 1998 (26.01.98)



in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

<p>The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland</p> <p>Facsimile No.: (41-22) 740.14.35</p>	<p>Authorized officer Ting Zhao</p> <p>Telephone No.: (41-22) 338.83.38</p>
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# PATENT COOPERATION TREATY

RECEIVED

09/214101

From the  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

**BCS**  
SCHAEFFER, Andrew L.  
E.I. DU PONT DE NEMOURS AND COMPANY  
Legal Patent Records Center  
1007 Market Street  
Wilmington, DE 19898  
ETATS-UNIS D'AMERIQUE

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NOTIFICATION OF TRANSMITTAL OF  
THE INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT  
(PCT Rule 71.1)

Date of mailing  
(day/month/year)

**23.09.98**

Applicant's or agent's file reference  
CR9939

## IMPORTANT NOTIFICATION

International application No.  
PCT/US97/11521

International filing date (day/month/year)  
30/06/1997

Priority date (day/month/year)  
01/07/1996

Applicant

E.I. DU PONT DE NEMOURS AND COMPANY et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

### 4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/

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# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY EXAMINATION REPORT



(PCT Article 36 and Rule 70)

Applicant's or agent's file reference CR9939	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (PCT/IPEA/416)	
International application No. PCT/US97/11521	International filing date (day/month/year) 30/06/1997	Priority date (day/month/year) 01/07/1996
International Patent Classification (IPC) or national classification and IPC C07D209/08		
Applicant E.I. DU PONT DE NEMOURS AND COMPANY et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 10 sheets, including this cover sheet.  
  
☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).  
  
 These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☒ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand  26/01/1998	Date of completion of this report  23. 09. 98
Name and mailing address of the IPEA/   European Patent Office D-80298 Munich Tel. (+49-89) 2399-0, Tx: 523656 epmu d Fax: (+49-89) 2399-4465	Authorized officer  Deutsch, W  Telephone No. (+49-89) 2399-8281  

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/US97/11521

**I. Basis of the report**

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

**Description, pages:**

1-16 as originally filed

**Claims, No.:**

1-17 as originally filed

18-30 as received on 19/08/1998 with letter of 14/08/1998

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:  
☐ the claims, Nos.:  
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

**IV. Lack of unity of invention**

1. In response to the invitation to restrict or pay additional fees the applicant has:

- ☐ restricted the claims.  
☐ paid additional fees.  
☐ paid additional fees under protest.  
☒ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/US97/11521

68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

☐ complied with.

☒ not complied with for the following reasons:

**see separate sheet**

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

☐ all parts.

☒ the parts relating to claims Nos. 19-30.

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes:	Claims	19-30
	No:	Claims	
Inventive step (IS)	Yes:	Claims	19-30
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	19-30
	No:	Claims	

2. Citations and explanations

**see separate sheet**

**VII. Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:

**see separate sheet**

**INTERNATIONAL PRELIMINARY  
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International application No. PCT/US97/11521

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**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

**see separate sheet**

IV

Reference is made to the following documents:

D1= R.Cramer et al., Journal of Organic Chemistry, vol. 40, no. 16, 8 August 1975, pages 2267-2273

D2= US 3 914 311

The international preliminary examining authority considers that the application does not comply with the requirements of unity of invention as set forth in the PCT regulations (Article 34(3), Rule 68(1) PCT).

The separate groups of invention are:

A: Claims relating to processes where organophosphines are ligands, the base has not been defined, the catalyst is given generally as comprising a zero valent nickel and an organophosphine ligand.

Claims 1-3,6,7,13,14,17,18

B: Claims where organophosphines are ligands and the bases are selected from 1,-diazabicyclo[5.4.0]undec-7ene, 1,5-diazabicyclo[4.3.0]non-5-ene potassium tert-butoxide - Claims 4,15

C: Claims where organophosphine are the ligands and the catalytic precursor is composition is a complex of Ni(cyclooctadiene)<sub>2</sub> and tricyclohexyl phosphine -

Claims 5 and 16

D: Claims where organophosphines are the ligands and the amine to be reacted is in the form of a salt -claims 8-12.

E: Claims where carbene is a ligand-Claims 19-30.

They are not so linked as to form a single general inventive concept (Rule 13.1 PCT) for the following reasons:

Experiments 6 and 7 given in table II of D1 discloses the amination of bromobenzene by aniline in the presence of [(C<sub>6</sub>H<sub>5</sub>)<sub>2</sub>PCH<sub>2</sub>]<sub>2</sub>Ni(CO)<sub>2</sub> catalyst. This reaction can be regarded as being as being carried out in the presence of a base, since the aniline is to

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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International application No. PCT/US97/11521

be regarded as a base. In the section "Aminations- Standard Conditions", page 2268 of D1 20 mmol of amine are used and 2mmol of aryl halide. These disclosures are considered to be novelty destroying to claims 1- 3. The term " a stoichiometric amount of a base is not considered to be a novel feature, since it is unclear to which reactant this relates or which numerical relationship is intended.

Experiments 1 to 6 disclosed in D1 are considered for analogous reasons to destroy the novelty of claims 13 and 14.

The disclosures of D2 are also considered to anticipate the disclosures of claims 1 -3 and 13 and 14

The requisite unity of invention (Rule 13.1 PCT) therefore no longer exists inasmuch as a technical relationship involving one or more of the same or corresponding special technical features in the sense of Rule 13.2 PCT does not exist between the subject-matter of the non-novel claims 1- 3, 13 - 14 and the remaining claims:

The technical features which distinguish inventions B to E from the D1 and D2 are completely different and do not share an inventive concept. Thus inter alia the case where a carbene is the ligand for the nickel is not considered to share a common technical feature with the case where the distinguishing technical feature is the base or the catalytic precursor is defined or the amine reactant is in the form of a salt.

Since, the Applicant failed to comply with the invitation to restrict the claims or pay additional fees, this Authority has established the preliminary report on those parts of the international application which relate to what appears to be the main invention (Invention E).



V

Reference is made to the following documents:

D1= R. Cramer et al., Journal of Organic Chemistry, vol. 40, no. 16, 8 August 1975, pages 2267-227

D2= US 3 914 311

D3= Chemical Abstracts, vol. 123, no. 15, 9 October 1995, abstract no. 198354t, H.J.Cristau et al., page 1202, & IND. CHEM LIBR., vol. , 1995, pages 240-263.

**Novelty**

The process of the present claims 19-30 differs from those disclosed in D1 and D2 through the presence of a carbene ligand in the catalyst, whereas in D1 and D2 this ligand has not been disclosed.

The process of the present claims 19-30 differs from that disclosed in D3 in that the nickel in the catalyst composition has a valency of zero, whereas in D3 the valency of the nickel is 2.

**Inventive Step**

The closest prior art is considered to be D2, since this discloses a very similar process to the present application. The only difference between the claimed process and that of D2, lies in the fact that carbene is present as a ligand to the nickel atom of the nickel complex, whereas such a ligand is not disclosed as a possible ligand in D2. Possible ligands disclosed in D2 are various phosphine ligands, cyclooctadiene, acetylacetonate and CO.

Inspection of Table VII of D2 shows that in the absence of catalyst the reaction of aniline

with chlorobenzene takes place to give diphenyl amine(see conversion to diphenyl amine - 0.12 %), whilst the presence of nickel catalyst increases the yield obtained. Thus it is considered that the skilled person could expect that also for the present application where alternative ligands to those given in D2, the diphenylamine would be obtained.

The problem underlying the present application is therefore considered to be the provision of a process having unexpected effects compared to the closest prior art process.

Comparison of Example 9 according to D2 with examples 106-108 of the present application, which both use aniline and bromobenzene appear to show that the claimed process generates an improved conversion compared to the D2 process.

Examples 106-108, which use nickel complexes with the carbene ligands (I) -(III) as catalysts are run at a much lower temperature (85°C) than the D2 process, which uses dicarbonyl-[bis(diphenyl-phosphino)]ethane nickel as a catalyst, but gives comparable or greatly improved yields.

It therefore appears that there is an inventive step is present in claims 19 to 30.

The term "optionally substituted" used in claims 19 and 25 is considered to encompass possibilities which would not be suitable for solving the problem underlying the application.

## VII

Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the document D1 to D3 are not mentioned in the description, nor are these documents identified therein.

The "two part form" has not been used for the present claims (Rule 6.3 (b) PCT).

VIII

a) The structure of the final product (the unsaturated nitrogen containing compound) has not been specified in claims 19 to 30 and it is unclear which structures it is intended to prepare, thus leading to a lack of clarity of claims 19 to 32 (Article 6 PCT).

b) Although the expression "a compound containing an NH or NH<sub>2</sub> functional group next to a carbon sp<sup>2</sup> centre" is understandable to the skilled person, it is not considered that the actual structures of the reactant are clearly defined.

c) The expression "an element more electronegative than carbon" used in claims 19 and 25 is considered to be unclear.

In view of the possible valencies of many elements, it would not be possible for many elements (without further substitution) to be bonded by a single bond to the carbon of the imidazole ring leading to a lack of clarity.

It has been indicated on page 4 of the description that also included in the definition of more electronegative than carbon are groups that are effectively more electronegative than carbon even though the atom bound to the imidazole ring may itself not be more electronegative than carbon. This definition in the description is not apparent from the claim, such that in the light of the description there is a lack of clarity of the claim.

This passage in the description also leads to a lack of clarity of claims 19 and 25 description, since it would imply that the term "element" is intended to encompass the term "group". The usual meaning of element does not normally encompass this meaning.

Having regard for the above mentioned specific meaning given in the description, this is considered to be a functional definition and is objected to, since it does not clearly define the intended structures.

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Thus, it appears that the applicant is attempting to define the invention in terms of a result to be achieved.

Furthermore the expression "electronegativity" is not considered to be a definition which is suitable for defining the invention, since it should be noted that the suitability of a particular element will depend on whether the group/element is electron withdrawing or releasing.

The electron withdrawing character of a group is not only dependent on the electronegativity of the atom directly bonded to the carbon but also on field effects as well as resonance effects.

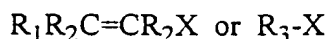
Similar arguments also apply to a "substituted element more electronegative to carbon".

The term "inert functional group" used in claims 23 and 30 is considered to be unclear, since this is considered to be a functional definition, which would put an undue burden on the skilled person wishing to find suitable groups. It is also unclear to what the functional group should be inert to.

18. The process of Claim 13 wherein X is iodide and R<sub>3</sub> is a phenyl group substituted with CF<sub>3</sub>.

19. A process for the production of unsaturated nitrogen containing compounds comprising:

reacting a compound containing an -NH- or -NH<sub>2</sub>- functional group next to a carbon sp<sup>2</sup> center with a compound of the formula



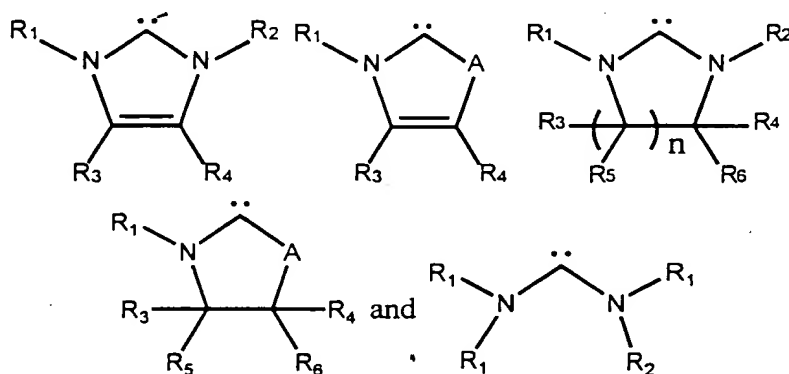
where X is either chloride, bromide, or iodide;

R<sub>1</sub> is either hydrogen, an alkyl group or an aryl group;

R<sub>2</sub> is independently selected from hydrogen, methyl or trimethylsilyl;  
and

R<sub>3</sub> is an optionally substituted aryl group;

in the presence of a stoichiometric amount of a base and a catalyst composition comprising comprising a zero-valent nickel and a carbene ligand selected from the group consisting of



wherein:

R<sup>1</sup> and R<sup>2</sup> are each independently hydrocarbyl or substituted hydrocarbyl;

R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup> and R<sup>6</sup> are independently an element more electronegative than carbon, a substituted element more electronegative than carbon, hydrogen, hydrocarbyl, substituted hydrocarbyl or an inert functional group;

n is an integer from 1 to 4; and

A is S or O;

whereby an unsaturated nitrogen containing compound is produced.

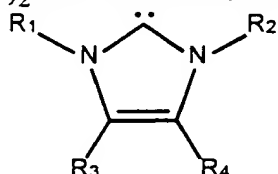
20. The process of Claim 19 wherein the unsaturated nitrogen containing compound is selected from the group consisting of enamides, enamines, aryl amines and aryl amides.

21. The process of Claim 19 wherein the compound containing -NH- or -NH<sub>2</sub>- functional groups is selected from the group consisting of primary and

secondary amides, anilines, imidazoles, carbamates, amidines, guanidines, amino thiazolines and ureas.

22. The process of Claim 19 wherein the base is selected from the group consisting of 1,8-diazabicyclo[5.4.0]undec-7-ene and 1,5-diazabicyclo[4.3.0]non-5-ene.

23. The process of Claim 19 wherein the catalyst precursor composition is a complex of  $\text{Ni}(\text{1,5-cyclooctadiene})_2$  and a carbene of the formula



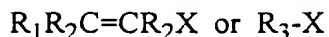
where  $R^1$  and  $R^2$  are independently selected from the group consisting of mesityl and adamantyl; and

$R^3$  and  $R^4$  are selected from the group consisting of methyl and hydrogen.

24. The process of Claim 19 wherein X is chloride and  $R_3$  is a phenyl group.

25. A process for the production of unsaturated nitrogen containing compounds comprising:

reacting the salt of a compound containing an -NH- or -NH<sub>2</sub>- functional group next to a carbon sp<sup>2</sup> center with a compound of the formula



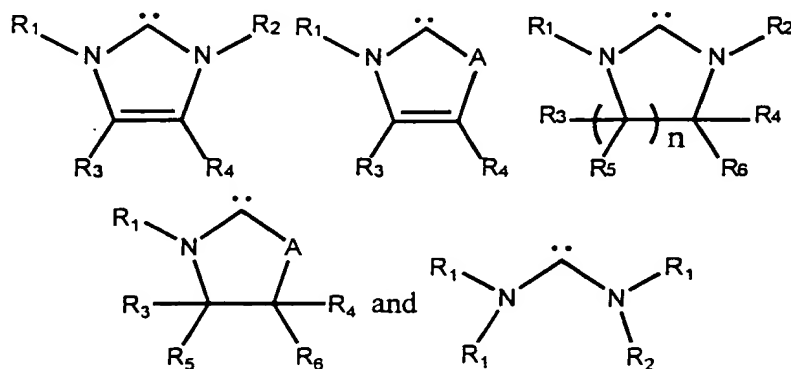
where X is either chloride, bromide, or iodide;

$R_1$  is either hydrogen, an alkyl group or an aryl group;

$R_2$  is independently selected from hydrogen, methyl or trimethylsilyl; and

$R_3$  is an optionally substituted aryl group;

in the presence of a stoichiometric amount of a base and a catalyst composition comprising comprising a zero-valent nickel and a carbene ligand selected from the group consisting of



wherein:

$R^1$  and  $R^2$  are each independently hydrocarbyl or substituted hydrocarbyl;

$R^3$ ,  $R^4$ ,  $R^5$  and  $R^6$  are independently an element more electronegative than carbon, a substituted element more electronegative than carbon, hydrogen, hydrocarbyl, substituted hydrocarbyl or an inert functional group;

$n$  is an integer from 1 to 4; and

A is S or O;

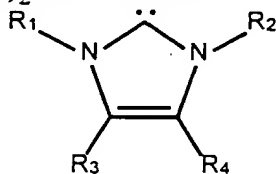
whereby an unsaturated nitrogen containing compound is produced.

26. The process of Claim 25 wherein the unsaturated nitrogen containing compound is selected from the group consisting of enamides, enamines, aryl amines and aryl amides.

27. The process of Claim 25 wherein the compound containing -NH- or -NH<sub>2</sub>- functional groups is selected from the group consisting of primary and secondary amides, anilines, imidazoles, carbamates, amidines, guanidines, amino thiazolines and ureas.

28. The process of Claim 25 wherein the base is selected from the group consisting of 1,8-diazabicyclo[5.4.0]undec-7-ene and 1,5-diazabicyclo[4.3.0]non-5-ene.

29. The process of Claim 25 wherein the catalyst precursor composition is a complex of Ni(1,5-cyclooctadiene)<sub>2</sub> and a carbene of the formula



where  $R^1$  and  $R^2$  are independently selected from the group consisting of mesityl and adamantyl; and

$R^3$  and  $R^4$  are selected from the group consisting of methyl and hydrogen.

30. The process of Claim 25 wherein X is chloride and  $R_3$  is a phenyl group.

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WORLD INTELLECTUAL PROPERTY ORGANIZATION  
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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>C07D 209/08, 209/10, 231/08</b>	<b>A1</b>	(11) International Publication Number: <b>WO 98/00399</b> (43) International Publication Date: <b>8 January 1998 (08.01.98)</b>
<p>(21) International Application Number: <b>PCT/US97/11521</b></p> <p>(22) International Filing Date: <b>30 June 1997 (30.06.97)</b></p> <p>(30) Priority Data: <b>60/021,170</b>      <b>1 July 1996 (01.07.96)</b>      <b>US</b></p> <p>(71) Applicant (for all designated States except US): <b>E.I. DU PONT DE NEMOURS AND COMPANY [US/US]; 1007 Market Street, Wilmington, DE 19898 (US).</b></p> <p>(72) Inventors; and (75) Inventors/Applicants (for US only): <b>BAKER, Ralph, Thomas [CA/US]; 110 Sierra Vista Drive, Los Alamos, NM 87544 (US). KRISTJÁNSDÓTTIR, Sigrídur, Sóley [IS/US]; 1406 Hamilton Street, Wilimington, DE 19806 (US).</b></p> <p>(74) Agents: <b>SCHAEFFER, Andrew, L. et al.; E.I. du Pont de Nemours and Company, Legal Patent Records Center, 1007 Market Street, Wilmington, DE 19898 (US).</b></p>	<p>(81) Designated States: <b>CA, JP, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</b></p> <p><b>Published</b> <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>	

(54) Title: **NICKEL CATALYZED ADDITION OF -NH- CONTAINING COMPOUNDS TO VINYL AND ARYL HALIDES**

## (57) Abstract

A process for producing unsaturated nitrogen containing compounds such as enamides, enamines and aryl amines/amides is disclosed. A vinyl halide or aryl halide is reacted with an -NH- containing compound in the presence of a catalytic amount of a catalyst precursor composition comprising a zero-valent nickel and an organophosphine or carbene ligand. One step coupling of vinyl halides and aryl halides with -NH- containing compounds is made possible by practice of the invention.



18. The process of Claim 13 wherein X is iodide and R<sub>3</sub> is a phenyl group substituted with CF<sub>3</sub>.

19. A process for the production of unsaturated nitrogen containing compounds comprising:

- 5 reacting a compound containing an -NH- or -NH<sub>2</sub>- functional group next to a carbon sp<sup>2</sup> center with a compound of the formula



where X is either chloride, bromide, or iodide;

R<sub>1</sub> is either hydrogen, an alkyl group or an aryl group;

10 R<sub>2</sub> is independently selected from hydrogen, methyl or trimethylsilyl; and

R<sub>3</sub> is an optionally substituted aryl group;

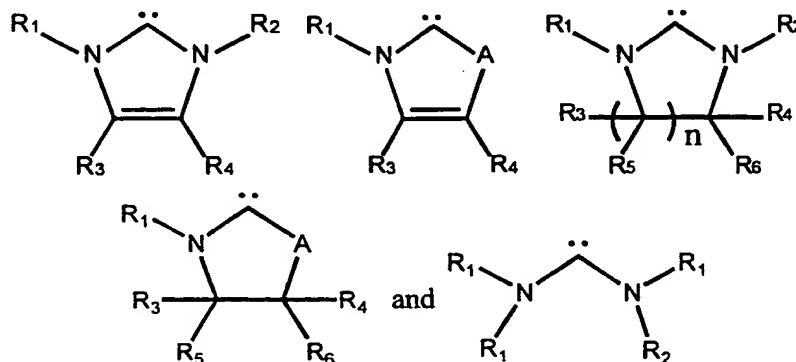
in the presence of a stoichiometric amount of a base and a catalyst composition comprising comprising a zero-valent nickel and a carbene ligand.

- 15 20. The process of Claim 19 wherein the unsaturated nitrogen containing compound is selected from the group consisting of enamides, enamines, aryl amines and aryl amides.

21. The process of Claim 19 wherein the compound containing -NH- or -NH<sub>2</sub>- functional groups is selected from the group consisting of primary and secondary amides, anilines, imidazoles, carbamates, amidines, guanidines, amino thiazolines and ureas.

22. The process of Claim 19 wherein the base is selected from the group consisting of 1,8-diazabicyclo[5.4.0]undec-7-ene and 1,5-diazabicyclo[4.3.0]non-5-ene.

- 25 23. The process of Claim 19 wherein the carbene is selected from the group consisting of



wherein:

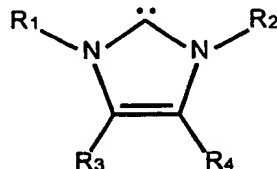
R<sup>1</sup> and R<sup>2</sup> are each independently hydrocarbyl or substituted hydrocarbyl;

$R^3$ ,  $R^4$ ,  $R^5$  and  $R^6$  are independently an element more electronegative than carbon, a substituted element more electronegative than carbon, hydrogen, hydrocarbyl, substituted hydrocarbyl or an inert functional group;

$n$  is an integer from 1 to 4; and

5 A is S or O.

24. The process of Claim 19 wherein the catalyst precursor composition is a complex of  $Ni(1,5\text{-cyclooctadiene})_2$  and a carbene of the formula



10 where  $R^1$  and  $R^2$  are independently selected from the group consisting of mesityl and adamantyl; and

$R^3$  and  $R^4$  are selected from the group consisting of methyl and hydrogen.

25. The process of Claim 19 wherein X is chloride and  $R_3$  is a phenyl group.

15 26. A process for the production of unsaturated nitrogen containing compounds comprising:

reacting the salt of a compound containing an -NH- or -NH<sub>2</sub>- functional group next to a carbon  $sp^2$  center with a compound of the formula



20 where X is either chloride, bromide, or iodide;

$R_1$  is either hydrogen, an alkyl group or an aryl group;

$R_2$  is independently selected from hydrogen, methyl or trimethylsilyl; and

$R_3$  is an optionally substituted aryl group;

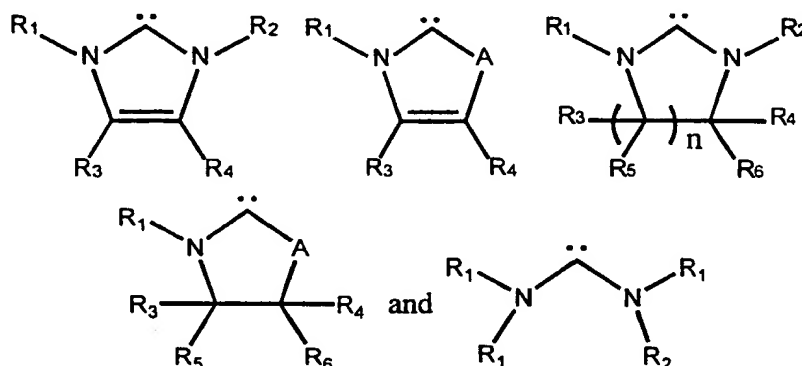
25 in the presence of a stoichiometric amount of a base and a catalyst composition comprising comprising a zero-valent nickel and a carbene ligand.

27. The process of Claim 26 wherein the unsaturated nitrogen containing compound is selected from the group consisting of enamides, enamines, aryl amines and aryl amides.

30 28. The process of Claim 26 wherein the compound containing -NH- or -NH<sub>2</sub>- functional groups is selected from the group consisting of primary and secondary amides, anilines, imidazoles, carbamates, amidines, guanidines, amino thiazolines and ureas.

29. The process of Claim 26 wherein the base is selected from the group consisting of 1,8-diazabicyclo[5.4.0]undec-7-ene and 1,5-diazabicyclo[4.3.0]non-5-ene.

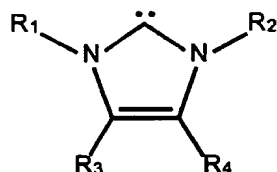
30. The process of Claim 26 wherein the carbene is selected from the  
5 group consisting of



wherein:

- $R^1$  and  $R^2$  are each independently hydrocarbyl or substituted hydrocarbyl;  
 $R^3$ ,  $R^4$ ,  $R^5$  and  $R^6$  are independently an element more electronegative than  
 10 carbon, a substituted element more electronegative than carbon, hydrogen,  
 hydrocarbyl, substituted hydrocarbyl or an inert functional group;  
 $n$  is an integer from 1 to 4; and  
 $A$  is S or O.

31. The process of Claim 26 wherein the catalyst precursor  
 15 composition is a complex of  $Ni(1,5\text{-cyclooctadiene})_2$  and a carbene of the  
 formula



where  $R^1$  and  $R^2$  are independently selected from the group  
 consisting of mesityl and adamantyl; and  
 $R^3$  and  $R^4$  are selected from the group consisting of methyl and  
 20 hydrogen.

32. The process of Claim 26 wherein X is chloride and  $R_3$  is a phenyl  
 group.

## PATENT COOPERATION TREATY

PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

09/214101

REC'D 29 SEP 1998

WIPO PCT

Applicant's or agent's file reference CR9939	<b>FOR FURTHER ACTION</b>	See Notification of Transmittal of International Preliminary Examination Report (PCT/IPEA/416)
International application No. PCT/US97/11521	International filing date (day/month/year) 30/06/1997	Priority date (day/month/year) 01/07/1996
International Patent Classification (IPC) or national classification and IPC C07D209/08		
Applicant E.I. DU PONT DE NEMOURS AND COMPANY et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 10 sheets, including this cover sheet.

- ☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☒ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 26/01/1998	Date of completion of this report 23.09.98
Name and mailing address of the IPEA/  European Patent Office D-80298 Munich Tel. (+49-89) 2399-0, Tx: 523656 epmu d Fax: (+49-89) 2399-4465	Authorized officer Deutsch, W Telephone No. (+49-89) 2399-8281 

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/US97/11521

## I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

### Description, pages:

1-16 as originally filed

### Claims, No.:

1-17 as originally filed

18-30 as received on 19/08/1998 with letter of 14/08/1998

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:  
☐ the claims, Nos.:  
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

## IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

- ☐ restricted the claims.  
☐ paid additional fees.  
☐ paid additional fees under protest.  
☒ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

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68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

☐ complied with.

☒ not complied with for the following reasons:

**see separate sheet**

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

☐ all parts.

☒ the parts relating to claims Nos. 19-30.

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

### 1. Statement

Novelty (N)	Yes:	Claims	19-30
	No:	Claims	
Inventive step (IS)	Yes:	Claims	19-30
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	19-30
	No:	Claims	

### 2. Citations and explanations

**see separate sheet**

## VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

**see separate sheet**

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**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

**see separate sheet**

IV

Reference is made to the following documents:

D1= R.Cramer et al., Journal of Organic Chemistry, vol. 40, no. 16, 8 August 1975, pages 2267-2273

D2= US 3 914 311

The international preliminary examining authority considers that the application does not comply with the requirements of unity of invention as set forth in the PCT regulations (Article 34(3), Rule 68(1) PCT).

The separate groups of invention are:

A: Claims relating to processes where organophosphines are ligands, the base has not been defined, the catalyst is given generally as comprising a zero valent nickel and an organophosphine ligand.

Claims 1-3,6,7,13,14,17,18

B: Claims where organophosphines are ligands and the bases are selected from 1,-diazabicyclo[5.4.0]undec-7ene, 1,5-diazabicyclo[4.3.0]non-5-ene potassium tert-butoxide - Claims 4,15

C: Claims where organophosphine are the ligands and the catalytic precursor is composition is a complex of Ni(cyclooctadiene)<sub>2</sub> and tricyclohexyl phosphine -

Claims 5 and 16

D: Claims where organophosphines are the ligands and the amine to be reacted is in the form of a salt -claims 8-12.

E: Claims where carbene is a ligand-Claims 19-30.

They are not so linked as to form a single general inventive concept (Rule 13.1 PCT) for the following reasons:

Experiments 6 and 7 given in table II of D1 discloses the amination of bromobenzene by aniline in the presence of  $[(C_6H_5)_2PCH_2]_2Ni(CO)_2$  catalyst. This reaction can be regarded as being as being carried out in the presence of a base, since the aniline is to



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be regarded as a base. In the section "Aminations- Standard Conditions", page 2268 of D1 20 mmol of amine are used and 2mmol of aryl halide. These disclosures are considered to be novelty destroying to claims 1- 3. The term " a stoichiometric amount of a base is not considered to be a novel feature, since it is unclear to which reactant this relates or which numerical relationship is intended.

Experiments 1 to 6 disclosed in D1 are considered for analogous reasons to destroy the novelty of claims 13 and 14.

The disclosures of D2 are also considered to anticipate the disclosures of claims 1 -3 and 13 and 14

The requisite unity of invention (Rule 13.1 PCT) therefore no longer exists inasmuch as a technical relationship involving one or more of the same or corresponding special technical features in the sense of Rule 13.2 PCT does not exist between the subject-matter of the non-novel claims 1- 3, 13 - 14 and the remaining claims:

The technical features which distinguish inventions B to E from the D1 and D2 are completely different and do not share an inventive concept. Thus inter alia the case where a carbene is the ligand for the nickel is not considered to share a common technical feature with the case where the distinguishing technical feature is the base or the catalytic precursor is defined or the amine reactant is in the form of a salt.

Since, the Applicant failed to comply with the invitation to restrict the claims or pay additional fees, this Authority has established the preliminary report on those parts of the international application which relate to what appears to be the main invention (Invention E).

V

Reference is made to the following documents:

D1= R. Cramer et al., Journal of Organic Chemistry, vol. 40, no. 16, 8 August 1975, pages 2267-227

D2= US 3 914 311

D3= Chemical Abstracts, vol. 123, no. 15, 9 October 1995, abstract no. 198354t, H.J.Cristau et al., page 1202, & IND. CHEM LIBR., vol. , 1995, pages 240-263.

**Novelty**

The process of the present claims 19-30 differs from those disclosed in D1 and D2 through the presence of a carbene ligand in the catalyst, whereas in D1 and D2 this ligand has not been disclosed.

The process of the present claims 19-30 differs from that disclosed in D3 in that the nickel in the catalyst composition has a valency of zero, whereas in D3 the valency of the nickel is 2.

**Inventive Step**

The closest prior art is considered to be D2, since this discloses a very similar process to the present application. The only difference between the claimed process and that of D2, lies in the fact that carbene is present as a ligand to the nickel atom of the nickel complex, whereas such a ligand is not disclosed as a possible ligand in D2. Possible ligands disclosed in D2 are various phosphine ligands, cyclooctadiene, acetylacetonate and CO.

Inspection of Table VII of D2 shows that in the absence of catalyst the reaction of aniline

with chlorobenzene takes place to give diphenyl amine(see conversion to diphenyl amine - 0.12 %), whilst the presence of nickel catalyst increases the yield obtained. Thus it is considered that the skilled person could expect that also for the present application where alternative ligands to those given in D2, the diphenylamine would be obtained.

The problem underlying the present application is therefore considered to be the provision of a process having unexpected effects compared to the closest prior art process.

Comparison of Example 9 according to D2 with examples 106-108 of the present application, which both use aniline and bromobenzene appear to show that the claimed process generates an improved conversion compared to the D2 process.

Examples 106-108, which use nickel complexes with the carbene ligands (I) -(III) as catalysts are run at a much lower temperature (85°C) than the D2 process, which uses dicarbonyl-[bis(diphenyl-phosphino)]ethane nickel as a catalyst, but gives comparable or greatly improved yields.

It therefore appears that there is an inventive step is present in claims 19 to 30.

The term "optionally substituted" used in claims 19 and 25 is considered to encompass possibilities which would not be suitable for solving the problem underlying the application.

## VII

Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the document D1 to D3 are not mentioned in the description, nor are these documents identified therein.

The "two part form" has not been used for the present claims (Rule 6.3 (b) PCT).

VIII

a) The structure of the final product (the unsaturated nitrogen containing compound) has not been specified in claims 19 to 30 and it is unclear which structures it is intended to prepare, thus leading to a lack of clarity of claims 19 to 32 (Article 6 PCT).

b) Although the expression "a compound containing an NH or NH<sub>2</sub> functional group next to a carbon sp<sup>2</sup> centre" is understandable to the skilled person, it is not considered that the actual structures of the reactant are clearly defined.

c) The expression "an element more electronegative than carbon" used in claims 19 and 25 is considered to be unclear.

In view of the possible valencies of many elements, it would not be possible for many elements (without further substitution) to be bonded by a single bond to the carbon of the imidazole ring leading to a lack of clarity.

It has been indicated on page 4 of the description that also included in the definition of more electronegative than carbon are groups that are effectively more electronegative than carbon even though the atom bound to the imidazole ring may itself not be more electronegative than carbon. This definition in the description is not apparent from the claim, such that in the light of the description there is a lack of clarity of the claim.

This passage in the description also leads to a lack of clarity of claims 19 and 25 description, since it would imply that the term "element" is intended to encompass the term "group". The usual meaning of element does not normally encompass this meaning.

Having regard for the above mentioned specific meaning given in the description, this is considered to be a functional definition and is objected to, since it does not clearly define the intended structures.

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Thus, it appears that the applicant is attempting to define the invention in terms of a result to be achieved.

Furthermore the expression "electronegativity" is not considered to be a definition which is suitable for defining the invention, since it should be noted that the suitability of a particular element will depend on whether the group/element is electron withdrawing or releasing.

The electron withdrawing character of a group is not only dependent on the electronegativity of the atom directly bonded to the carbon but also on field effects as well as resonance effects.

Similar arguments also apply to a "substituted element more electronegative to carbon".

The term "inert functional group" used in claims 23 and 30 is considered to be unclear, since this is considered to be a functional definition, which would put an undue burden on the skilled person wishing to find suitable groups. It is also unclear to what the functional group should be inert to.

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 97/11521

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3914311 A	21-10-75	NONE	
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EP 385835 A	05-09-90	FR 2643902 A	07-09-90
		CA 2011353 A	03-09-90
		JP 2282349 A	19-11-90
		US 5053541 A	01-10-91
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		EP 0613720 A	07-09-94
		JP 7002888 A	06-01-95
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